Al Jessel
Senior Fuels Policy Advisor

Product Engineering, Regulations, and Technology
Chevron Products Company
6001 Bollinger Canyon Road, L2269
San Ramon, CA 94583-2324
Tel (949) 856-2958
ajje@chevron.com

March 22, 2007

California Energy Commission
Docket Office
Attn: Docket No. 06-AFP-1
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512

RE: Docket No. 06-AFP-1, Alternative Transportation Fuels Plan Full Fuel Cycle Analysis.

On the behalf of Chevron, we are pleased to provide comments on studies and presentations prepared in support of the California Energy Commission's (CEC) Alternative Transportation Fuels Plan Full Fuel Cycle Analysis. These comments pertain to materials reviewed during the March 2, 2007, Joint CEC & ARB Workshop on the Development of the Alternative Transportation Fuels Plan. We appreciate the CEC's effort to bring understanding and perspective to the critical issue of ensuring adequate energy supplies for California in the coming decades.

We support evaluation of the various transportation fuel alternatives using a full fuel cycle analysis, as is done in these reports. The nature of such studies makes transparency and objectivity critical. In addition, the introduction of the Governor's Low Carbon Fuel Standard (LCFS) provides an additional perspective from which to view this work.

The comments that follow are in response to the workshop materials and presentations. Most of our comments are directed at the three draft reports prepared by TIAX: "Full Fuel Cycle Assessment Well to Wheels Energy Inputs, Emissions, and Water Impacts" (WTW); "Full Fuel Cycle Assessment Well to Tank Energy Inputs, Emissions, and Water Impacts" (WTT); and "Full Fuel Cycle Assessment Tank to Wheels Energy Inputs, Emissions, and Water Impacts" (TTW).

General Comments

It is recognized that the TIAX work is based on an analysis of the marginal supply of fuels to the state transportation pool. While this basis has some utility in evaluating various alternatives against one another, it is not directly applicable in terms of the LCFS. Scenario development and compliance with the LCFS will require full fuel cycle impacts to be addressed as they exist in the total transportation fuel pool.

This report is quite readable, and we commend the authors for their effort. But there are areas where we believe improvements can be made in completeness and accuracy. References and explanations for some key assumptions are missing. In addition, there appears to be a pattern of assumption that over promises the benefits of fuels that have not been tested in widespread consumer use. In many cases, assumptions for alternative fuels appear to be based on the more optimistic of the studies in the literature. Consideration of a wider range of credible studies, including less optimistic ones, would be helpful to improve balance.

Refinery Estimates

The TIAX estimates do not accurately describe California refineries (especially Chevron's) and would not be useable as an accurate baseline for the LCFS. Examples:

- The MathPro modeling appears superficial and overly generic, is rather out of date (1999) and significantly understates refinery efficiency (WTT pages 3-2, 3-3)
- The amount of energy ascribed to making gasoline and diesel in Table 3-1 (WTT page 3-3) seems high. The ratio for gasoline is (157,000/115,000) or 1.36. This number takes into account only the refining step. By contrast, the well to tank analysis shown in Figure 7-1 (WTT page 7-4) shows the total energy (production, transportation, refining, plus combustion) to be only about 1.25 times the combustion energy for gasoline.
- Also in Table 3-1, it is not clear why the BTU/gallon energy associated with making ULSD versus diesel (178,500 vs. 163,000) is so much larger than the difference between diesel and RFG (163,000 vs. 157,000). Diesel is typically treated anyway and increasing the treating severity alone should not cause such a big difference in energy use. It appears that the gasoline figures are based on a California analysis, while the diesel figures are based on a non-California analysis; this could explain some of the difference.
- In Table 3-2 (WTT page 3-4) the hydrogen requirements are understated at least several-fold and the source of the information is not clear.
- In Table 2-4 (WTT page 2-13), H/C and gCO2/MJ values are inaccurate for CARBOB and ULSD.
- There is no recognition of continuing efficiency improvements. For example, for its overall operations Chevron has reduced its energy use per unit of output by nearly 24% over the past 14 years.

Fuel Storage and Distribution

In WTT section 5, it appears that many of the emissions factors for tank losses, gasoline refueling losses, phase II vapor recovery, and evaporative emissions do not reflect the latest California standards and practices. The assumption that all California alternative fuel production equipment will be in populated ozone nonattainment areas (thus subject to BACT rather than RACT emissions standards) lacks plausibility and needs to be explained better (WTT pages 5-3 and 5-5).

Multimedia Impacts

It is important to understand the myriad of impacts of introducing a new fuel into the environment. In essence, the TIAX report appears to take the stance that any reduction in hydrocarbon fuels is a plus, regardless of its replacement's composition. The report states that "Fuels that contain no petroleum hydrocarbons do not have a substantial multimedia impact associated with their use in California" (WTW page 4-11).

That there are significant multi-media concerns about the replacement of petroleum components with chemicals such as di-methyl ether and methanol is made amply clear by the fact that they are not allowed for use in California gasoline. Paragraph (c) of section 2262.6 of Title 13 of the California Code of regulations states:

> Use of oxygenates other than ethanol or MTBE in California gasoline on or after December 31, 2003.
>
> (1) Starting December 31, 2003, no person shall sell, offer for sale, supply or offer for supply California gasoline which has been produced at a California production facility with the use of any oxygenate other than ethanol or MTBE unless a multimedia evaluation of use of the oxygenate in California gasoline has been conducted and the California Environmental Policy Council established by Public Resources Code section 71017 has determined that such use will not cause a significant adverse impact on the public health or the environment.

The multi-media impacts section of the report needs to better reflect these concerns.

Also in the Multimedia Impacts section, oil spills, petroleum-related accidents, etc. are considered in extensive detail (e.g., WTT pages 6-7 to 6-15). However, such incidents from alternative fuels receive little attention. When mentioned, they are said not to be a problem, often based on incomplete or speculative assertions. For example, one incident not mentioned is the 2004 explosion and sinking of the ethanol tanker Bow Mariner off the New Jersey coast, which killed several of its crew. This incident is omitted from any of the discussions. Also omitted is discussion of possible frequency increase of any such problems with very large increases of biofuel use envisioned for California.

Analysis of E85

The analysis of E85 does not take into account the need to meet minimum vapor pressure specifications as defined by ASTM D 5798-06, "Standard Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark-Ignition Engines" which is required by California regulations. In Chevron's joint project with ARB, Caltrans, GM and Pacific Ethanol for which two refueling stations have been installed, the E85 must be blended first at a terminal loading rack and then at our research facilities due to the need to add a third component to the gasoline/ethanol mixture. A common misconception about blending E85 is that because both gasoline and ethanol are available at many petroleum terminals, they simply need to be combined in the loading of delivery trucks serving retail outlets at a ratio of 85% by volume denatured ethanol and 15% by volume gasoline. In fact, in order to meet changing vehicle needs with the seasons, the denatured ethanol fraction is permitted to range from about 75% to 85% and the gasoline fraction from about 15-25%.

In California, the minimum vapor pressure for E85 is required to be 5.5 psi to 9.5 psi depending on location and month of the year, but the vapor pressures of the gasoline (CARBOB) at the terminal and ethanol are typically too low for any mixture within the allowed range to meet the minimum limit. For instance, the summer-time minimum vapor pressure of 5.5 psi cannot be met with a combination of summer CARBOB at roughly 5.5 psi and ethanol at roughly 2.3 psi. Thus, a third, relatively high vapor pressure component must be added. In the joint E85 study Chevron has the responsibility for blending the E85 to specification and we've been using refinery-produced iso-pentane which we blend at our research facility in Richmond in small batches, by hand. In a large volume scale-up, terminal blending of the third component would necessitate a third logistics train supported by a local refinery. Transporting and terminal-blending a relatively high vapor pressure component adds a significant element to the E85 equation with implications for distribution emissions and GHG emissions from transport. This complication to E85 blending should be taken into account in the TIAX report.

<u>Impacts of Gasoline and Diesel Vehicles</u>

The fuel economy for gasoline and diesel cars is not assumed to improve very much; substantially less than other studies (for example, those of John Heywood at MIT) have projected. This small improvement occurs despite the fact that this study looks forward to 2030. Tables 3.1 and 3.2 (TTW page 3-3) are represented as being consistent with AB1493 requirements (30% GHG reduction by 2016) in footnotes to these tables. However, only enough fuel economy improvement is shown (1.2%-1.5%/yr) to achieve about half this GHG reduction. For example, in Table 3-2, the assumed fuel economy of a midsize passenger car is only ~26 mpg in 2012 and ~32 mpg in 2030.

TTW Section 3.2.3 (pages 3-9 and 10) includes an inaccurate statement that suggests that diesel vehicles are not considered to be an option to replace gasoline vehicles because of emissions concerns. In fact, several manufacturers have already announced plans to market LDVs that meet the California emissions standards. Later in that section, it is suggested that direct injection gasoline could match diesel's fuel consumption, even though no manufacturer has demonstrated an ability to meet California emission requirements with a lean-burn DI engine (note that stoichiometric DI engines are currently marketed, but cannot match diesel fuel consumption). In addition, diesel hybrids should be included in the analysis.

<u>Hydrogen for Vehicles</u>

Many of the parameters for hydrogen for vehicles appear to be overly optimistic. Examples:

- Required H2 purity is represented as 98% for fuel cell vehicles (WTT page 3-25). Much higher purity than this (99.99+%) is typically required.
- H2 from electrolysis is represented as requiring 48 kWh per kg including compression (WTT page 3-27). Actual systems require significantly more.
- A special renewable electricity mix (70% renewable electricity) is assumed only for some H2 from electrolysis pathways and not for any of the other fuels (WTT page 7-35). The plausibility of this assumption needs to be explained, as well as why it is assumed only for this pathway and not for the others.
- Significantly higher reformation/purification efficiencies (74%) are assumed than are achieved in practice for the highly purified hydrogen used for fuel cell vehicles (WTT page 7-37). The

process and compression electricity requirements in Table 7-24 (WTT page 7-37) are understated by about a factor of 2, based on our experience

In addition, very large fuel economy improvements are projected for hydrogen ICE and fuel cell vehicles, contrary to actual data presently available. Overly optimistic values also appear to be applied to vehicles using grid electricity.

- In Figure 3-3 (TTW page 3-7), the ratio between hydrogen fuel cell HEV fuel economy (~48 mpgge on average) and a gasoline HEV (~30 mpgge on average) is shown to be 48/30 = 1.6. However, actual EPA fuel economy data show a ratio of 1.04 (see Appendix 1). However, these EPA data were not considered in the TIAX analysis.
- Also in Figure 3.3, it appears that the ratio between a H2 ICE/HEV and a gasoline HEV is 35/30 mpg = 1.17. However, as noted in footnote (d) on page 3-12, a Prius hybrid converted to hydrogen in a SCAQMD program actually showed a fuel economy decrease after conversion.
- Additional speculative statements about hydrogen vehicle fuel economy values of 1.8 to 2.5x those of conventional vehicles, contrary to actual data, are also made on TTW page 3-13 without any supporting data.

<u>Alt Fuel Vehicles</u>

In TTW Figure 3.3, the average gasoline fuel economy of a PHEV is shown to be nearly 10% better than that of a gasoline HEV, despite a likely added weight of several hundred pounds of batteries.

More discussion is needed for the basis of criteria pollutant adjustment factors for alternative fueled vehicles. In Tables 4-9 and 4-10 (TTW pages 4-12 and 4-13), more background is needed on why GREET ratios should be used here, and the references used for these values.

<u>Electricity Generation Assumptions</u>

California incremental electricity is selectively ascribed only to the cleanest generation, and does not represent the real-world CA incremental electricity mix or economic dispatch. Examples are:

- Regardless of when the electricity is needed for electric vehicles, it is always assumed to come exclusively from the most efficient, cleanest new gas turbine combined cycle power plants and renewable energy (WTT page 3-58, 3-62, and 3-63). In the real world, other, higher carbon and higher emissions power generation resources will provide the marginal electricity at times.
- It is assumed that the 2010 20% California Renewable Portfolio Standard (RPS) for electricity will be met (page 3-58) even though it is clear it will not.

<u>Impacts of Biofuels</u>

Some key biofuel environmental impacts appear to be selectively downplayed, ignored, or said to beyond the work scope. Examples:

- It is assumed that the water impacts of producing biomass feedstocks in California are negligible (WTT page 6-6)

- Treatment of impacts of agricultural runoff on water quality, even for biofuel feedstock grown in California, is categorized as “beyond the scope of this work” and is not considered (WTT page 6-7).
- Biofuels (ethanol and biodiesel) and synthetic fuels are all assumed to be produced out of state and therefore assumed are assumed to have no HC releases in California (WTT page 6-21). However, in other places (e.g., the footnote at the bottom of WTT page 6-18 where a California Pacific Ethanol plant site certification is mentioned) in-state plants of this type are discussed.

Conclusion

Chevron is working to provide reliable, affordable energy, produced in a safe and environmentally responsible manner. As part of our broader energy development strategy, we are actively engaged in developing diversified energy resources that can be commercially competitive.

We recognize that all commercially competitive sources of energy will be needed. An unbiased WTW analysis of the alternatives, relying best-available information and consistent assumptions, can be a very useful step in helping to sort out the best options. Our comments are provided in that spirit, and we hope that they prove to be valuable and constructive.

We appreciate your consideration of our comments. Please contact me at (949) 856-2958 if you have any questions or would like more information.

Sincerely,

Al Jessel

cc: McKinley Addy
T. T. Kutz
H. W. Sigworth
J. P. Uihlein

Appendix 1: Fuel Economy Using Today's Data—
Fuel Cell and Gasoline Hybrid-Electric Vehicles

Some recent EPA fuel economy data for fuel cell and gasoline hybrid-electric vehicles are summarized below.

EPA fuel economy results from actual certification testing of three fuel cell vehicles have been reported in recent (2006 and 2007) EPA/DOE Fuel Economy Guides[1 2]. These vehicles are all fueled directly by hydrogen stored in compressed form on board, and are all classified as subcompact or compact passenger cars. They are also all hybrids, and have substantial electric storage capacity (NiMh batteries or ultracapacitors) like common gasoline-electric hybrids such as the Prius or Civic hybrid. This helps allows them to achieve higher fuel economy by recovering energy from braking and other hybrid benefits.

Table 1. Hybrid-Electric H2 Fuel Cell Vehicle Fuel Economy Test Results

Vehicle Description	EPA City Miles p H2	EPA Highwa Miles per kg I	EPA Combine Miles per kg H2
Mercedes F-Cell (Subcompact, Ref. 1)	57	58	57.4
Honda FCX (Subcompact, Ref. 2)	62	51	56.5
Ford Focus Fuel Cell (Compact, Ref. 2)	48	53	50.1
Average =			54.7

*Weighted 55% City, 45% Highway per EPA

Because the fuel cell vehicles are all hybrids (i.e., have substantial battery capacity) it is appropriate to compare them with I.C. engine hybrids. Hybridization benefits apply to both fuel cell and I.C. engine vehicles. Comparing a conventional (non-hybrid) I.C engine vehicle to a hybrid fuel cell vehicle would in effect credit the fuel cell with both the H2 fuel cell benefits and the hybridization benefits together. To make an accurate comparison, these benefits should be separated; otherwise, this leads to an incorrect "apples and oranges" comparison.

Accordingly, the EPA fuel economy test results for the two current (2007) hybrid gasoline passenger cars nearest the subcompact/compact size range of the fuel cell ones in Table 1 are summarized in Table 2.

Table 2. Hybrid-Electric Gasoline Vehicle Fuel Economy Test Results

Vehicle Description	EPA City MP	EPA Highwa MPG	EPA Combine MPG*
Honda Civic Hybrid (Compact, Ref. 1)	49	51	49.9
Toyota Prius Hybrid (Mid-sized, Ref. 1)	60	51	55.6
Average =			52.7

*Weighted 55% City, 45% Highway per EPA

These results indicate that based on EPA certification testing, the average fuel economy of the fuel cell vehicles is only about 4% higher than that of comparable gasoline hybrid electric vehicles.

---

[1] EPA Model Year 2007 Fuel Economy Guide. Available at www.fueleconomy.gov
[2] EPA Model Year 2006 Fuel Economy Guide. Available at www.fueleconomy.gov